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Chips from the Quarry

NOTES AND NOTEBOOKS

One of the most encouraging signs for the increasing popularity of mineralogy is the large number of collectors who are keeping notes on minerals and their localities. Even youngsters, 12 years old, have been seen making notes. This system not only increases their fund of mineralogic knowledge but it acts as a stimulus for a greater and more wider interest in the subject. What notes to make or what to stress is up to the collector himself but perhaps some reference to our method may be of value to others.

We have three sets of notebooks, three sets of index cards and three sets of folders.

Whenever we visit a locality, museum, or collector, one small notebook is always taken along. These notebooks are lettered A, B, C,—our last one is N—and each page is numbered, beginning with 1. Every locality, museum or collector visited is recorded and items of mineralogic interest jotted down. The date is noted and also the names of all who may accompany us. If the locality is a new one to us, a sketch is made of it and of its location in reference to nearest town or city.

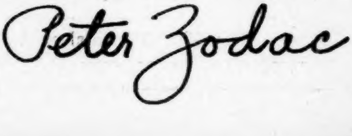
On return to the office, the trip (with its localities), is noted in a diary kept especially for this purpose. We have a number of these diaries, two of which run for 5 years each. These are set No. 2.

The third set consists of three books in which are recorded, by states and countries, the locations of interesting locatities given us by collectors. Many times when going out on trips we take one or all of these books to assist us in finding localities should we be searching for them.

The index cards list alphabetically all localities, museums, collectors visited by us. One set is devoted to localities by states (except New York); another is devoted to localities of New York by counties; and the third set is devoted to musuems, collectors and clubs. Each index card records all visits made to that particular locality, the dates, and also gives the letters and page numbers of the notebooks in which its notes appear.

The folders are large envelopes, 9 x 12 inches in size,in which are inserted notes on minerals of every locality brought to our attention, whether visited by us or not. Only definite localities are recorded and if notes are taken from some printed reference, the name, date and page number of the magazine or book is always attached. One set is devoted to all states of the Union except New York; another is devoted to New York exclusively (by counties); the third set for foreign countries. As New York has 62 counties and the Union over 50 states and territories, the number of envelopes in use is well over 200.

All these notes have been of tremendous interest and value to us. If you want to increase your knowledge of mineralogy—make notes on the subject and file them away for future reference.



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A MINERALOGICAL TRIP THROUGH THE MICHIGAN IRON RANGES

By KIRIL SPIROFF

Michigan College of Mining and Technology.

To the serious student of geology the Michigan iron ranges, especially in the vicinity of the city of Marquette, offer a field of wonderful opportunity to observe and study the processes of nature. These ranges and the territory surrounding them illustrate important geological features, and the rock outcrops expose many interesting rocks and minerals.

Minerals are beautiful in themselves, but when their history and environment are unravelled and interpreted, how much more interesting they become! The specimen may be only a stone to some, but it is an open book to you. Every mineral speck, every cleavage flash tells a story. Minerals did not simply happen; the underlying causes of their formation are found in the records of the past. Further, rocks should not be classified as dead, inert masses; they are to be considered as having participated in earth changes of which evidences confront us on every side.

In the upper peninsula of Michigan the bedrock formations include some of the oldest rocks known. Many of these were originally gravels, sands, marls, and silts, deposited in the shallow seas or perhaps on great outwash plains that existed in this region a billion or more years ago.

A unique feature of these old rocks is the presence of iron formations. The total quantity of iron-bearing minerals (siderite, greenalite, limonite, hematite, and magnetite) deposited in the shallow seas of this period has never been duplicated in the earth's subsequent history, but only a very small percentage of the resultant iron formation, much less than 1%, was later concentrated by natural processess into commercial iron ore.

The first mining of iron ore in the Lake Superior district began in 1848; the ore was hauled by team to a forge near Carp River, but the project was not successful. However, within the next few years numerous other attempts were made to smelt iron ore near the mines; even today some of the old furnaces and charcoal kilns are still standing, monuments to the efforts of the early iron-ore developers. One of the earliest difficulties, that of transportation to market, was removed by the building of railroads to the mines and by the opening of the Sault Canal in 1855. The permanent success of the mines was assured when, as a result of the large demand for iron during the Civil war, a close relationship was formed between the mines of the Lake Superior region and the furnaces and iron markets of the Lake Erie and the Pittsburgh districts. For many years the iron deposits of this region have yielded from 80 - 90% of the iron produced in the United States, and until 1901 Michigan was the leading producer. At that time production dropped, and Minnesota took the leading place. The largest shipment of the last twenty-five

years was in 1916, shipment of 18,812,-972 tons; the lowest was in 1932, shipment of 978,371 tons. The total production to date is over half a billion tons, or a tonnage equivalent to the total excavation of the Panama Canal.

In Michigan most of the iron ore is mined by underground methods. The Eureka shaft at Ramsay is over 3,500 feet in depth. In a typical mine the processess involved are as follows: the ore is mined, loaded into cars, hauled to the shaft bin, and hoisted to the surface in skips; from there the ore is loaded directly into railroad cars for shipment to the docks at Escanaba or Marquette, or it is stored at the stock piles. The open pit mines are located near Wakefield. Here the ore is loaded directly into railroad cars and shipped to the docks.

The value of the iron ore depends upon the iron content. Prices are quoted on 51.50% of iron, with penalties for leaner ore and premiums for ore of higher iron content. In addition to the iron content the percentages of phosphorous, sulphur, alumina, silica, and manganese have much to do with the value of the ore. Besides the proper chemical analysis, certain structural characteristics are desired by the blast-furnace operators.

We will start our mineralogical trip at the beautiful Presque Isle, a few miles north of Marquette, Michigan, at the point known as Pulpit Rock. Spread out before us are the deep blue waters of Lake Superior with, perhaps, ore boats visible in the distance. We are so absorbed in the scene that we fail to notice the black rock at our feet. However, upon walking down to the edge of the water, we are startled by a sharp contrast in the color of the rocks. The cliff is composed of red rocks in immediate contact with black rocks. As we look more closely along the cliff, we notice a layer of rock containing water-worn pebbles, and beneath it a series of caves.

The red rock and the black rock are fundamentally the same. Both are peridotites. The difference in appearance is due to weathering and to a fault movement that has placed fresh (unaltered) black peridotite next to altered red peridotite. Apparently, this spot offers an excellent opportunity for us to observe how weathering alters and changes the appearance of basic rocks.

Specimen No. 1. Fresh peridotite. A dark basic rock in which large cleavage flashes of a bronze-appearing mineral can be seen. These flashes are due to a pyroxene, either diallage or bronzite in variety. The dense material is serpentine (largely produced by the alteration of olivine) and magnetite.

Specimen No. 2. Altered peridotite. The specimen is composed essentially of iron oxides and serpentine intersected by veins of dolomite and chert, but its appearance depends upon the stage of weathering. From the veins of this rock, many minerals suitable for micromounts can be collected, the most common ones being specularite (thin flat rhombs) and calcite. Occasionally galena, asbestos and native silver are found.

On the southwest side of Presque Isle highly weathered peridotite and granite in contact with sandstone can be seen.

We complete the circle of the island, and as we pass the ore docks towards the city of Marquette we stop at the outcrop just south of the bridge over Dead River.

This granite outcrop is cut by pegmatites and veins of epidote. By some, the granite is considered to be one of the oldest existing rocks (Laurentian). Its age, perhaps, is over a billion years.

Specimen No. 3. Granite obtained from the outcrop on the lake shore. Its essential constituents are about 25% quartz, 65% light-colored feldspar. Both the alkali feldspar (orthoclase) and the calcic feldspar (plagioclase) are present. The ratio of orthoclase to plagioclase is about 3:1. The colored constituents are more or less altered. The dull green mineral is mostly chlorite, an alteration product of the original mica and amphibole. The light green mineral is epidote, probably of secondary origin. In a few of the veins fair specimens of epidote suitable for micro-mounts can be collected.

The next stop is at a small outcrop, just east of the cemetery. This outcrop is of such interest that an iron fence should be placed around it to keep people from defacing it! Here we see many things. The rock has been grooved and polished by glaciation—a typical *roche moutonnee*. The north side of the exposure is gently sloping and polished, while the south side is steep and rough because of glacial plucking. These conditions show that the glacier came from the north, a fact further proved by the deep groove running from north to south on the east side. This *roche moutonnee* outcrop consists of chloritic and sericitic schists cut by a north-south diabase dike. The width of the dike varies, being least where the schist is most dense. Within the dike are granitic fragments. These fragments show assimilation—that is, the edges were fused and partly dissolved by the originally molten material of the dike Faulting has occurred, affecting all these rocks; even some of the granitic fragments show displacement.

No samples will be taken here. Better samples of the same materials may be obtained at other stops.

From here we go to the Harvey quarry, three miles south of Marquette. The specimens described herein are gathered from the south end to the north end of the quarry, then continuing in the same direction along the edge of the cliff to the main road.

Specimen No. 4. Chloritic schist. A highly schistose, heavy green rock with a peculiar sheen in reflected light. The green color is due to the mineral chlorite.

Altered dikes cut the schist, as do veins of quartz and of ankerite. The schist is considered to be a member of the basement complex (Keewatin), and, with granite specimen No. 3, constitutes one of the oldest known rocks of the earth.

Specimen No. 5. Quartzite. A hard, tough, light-colored rock, consisting almost entirely of quartz. (Quartzite fractures through the sand grains, instead of around them as does sandstone.) Outlines of the original, rounded sand grains are still visible.

Specimen No. 6. Slate. Gray color. Breaks into thin sheets with a slaty cleavage. The rock, however, does not split parallel to the bedding as does shale. Small, scattered flakes of mica may be seen parallel to the cleavage planes. A slate is a shale that has developed good rock cleavage through metamorphism.

Specimen No. 7. Dolomite. Pink on freshly broken surface. The weathered surface is white, with small ridges of fantastic shapes. Some of these ridges are due to included chert which was deposited simultaneously with the calcareous material, but now it does not weather as rapidly as the dolomite; or the ridges may be due to algae — a low form of plant capable of secreting silica.

We retrace our route to Marquette and go toward Negaunee on M-35. We stop where the road goes through a cut in a quartzite ridge. Here the angular unconformity between quartzites of two different eras is well shown. The northerly exposures are the older.

Specimen No. 8. Quartzite, similar to No. 5, but pink.

Specimen No 9. Quartzite. White with red spots.

The next stop is at two ridges a few yards south on the dirt road. The first ridge shows slate with inter-bedded quartzite and graywacke. The more southerly ridge is a slate.

Specimen No. 10. Slate. Shows banding due to original sedimentation of ferruginous laminae, which are now at an angle to the slaty cleavage. The ferruginous bands in the slate indicate the beginning of the deposition of the iron ore-bearing formation.

Specimen No. 11. Greywacke. An impure sandstone containing grains of feldspar and mud, in addition to quartz that has been recrystallized.

Specimen No. 12. Slaty Quartzite. A quartzite that has a poor rock cleavage. The scattered flakes of mica causing such cleavage as is present are easily seen.

From here we go to the Athens Mine. At the railroad track, due north of the mine shaft, is an outcrop of cherty carbonate that shows glacial striations. The limonitic coating is due to alteration of the siderite. In connection with this outcrop the following proof is sometimes advanced to establish the length of time since glaciation: siderite on the dumps that were mined over 50 years ago shows a coating of limonitic material which has a thickness of about one cigarette paper. The thickness of the limonitic coating in the glaciated outcrop is equal to that of 1000 cigarette papers. Since 50 times 1000 equals 50,000, the glacier passed this spot 50,000 years ago. This figure represents the minimum time, and could be multiplied by two, four, or even ten to make up for retardation; once a coating of limonitic material is formed over the carbonate, it acts as a protection against rapid deterioration.

Specimen No. 13 Siderite. Gray and dense when freshly broken. Limonitic material is present on the surface, as are ridges of hard, flinty chert.

A small hill to the west of the Athens shaft shows the general structure of the vicinity—an anticlinal fold with a westward pitch. Ordinarily the iron-ore bodies are found in synclinal axes pitching westward. Near the shafts at the discarded ore dumps or in abandoned open pits (the North Jackson and the South Jackson) various iron minerals are to be found. The open pits are in town, and any gas station attendant will point them out.

Specimen. No. 14. Limonite. An earthy, yellow-to-brown mineral with a very definite yellow streak. Never crystallized, but not infrequently botryoidal and concretionary. Chemically, limonite is hematite plus water. It is not so rich an ore mineral as hematite, but is mined along with the other iron oxides. There is even a question as to the existence of such a mineral as limonite. X-rays reveal it to be a very fine-grained goethite.

Specimen No. 15. Goethite. A brownish, fibrous mineral showing one perfect cleavage. Streak yellow. Small, beautiful, orthorhombic crystals are found in vugs. Chemically, goethite is similar to limonite, although it has less water. It can be readily distinguished from limonite by its cleavage.

Specimen No. 16. Hematite. A dense variety of hematite, showing fibrous structure, deposited in concretionary or mammillary masses. This is known as kidney ore. Some collectors treat the surface with a stove polish and thus produce a very bright and attractive specimen.

Earthy, red ocher, or "rouge," is soft, without luster, and has a bright red color.

Pencil ore occurs as masses of exceptionally large fibres.

Hematite has a red streak and a specific gravity of 5. Its chemical composition is an iron oxide; having 30% oxygen, 70% iron.

At the North Jackson pit various structural relations and an unconformity are to be noticed; conglomerate ore, jaspilite, and soft ore along the dike are the most noticeable materials.

Specimen No. 17. Iron ore conglomerate. Pebbles of hematite and jasper surrounded and cemented by grains of hematite and iron formation members.

The pyramidal monument marks the spot where, beneath a fallen pine tree, iron ore was first found in the Lake Superior district. To the south of the monument is a diorite outcrop—one of the many conspicuous knobs formed in the area by intrusive diorite.

Specimen No. 18. Diorite. A tough, dense rock consisting chiefly of calcic feldspar and amphibole.

At the South Jackson pit, the iron ore was mined in a structural trough formed by a dike cutting the iron formation. This dike can be seen on the south wall of the pit. In the northeastern part of the pit barite and manganese minerals are found.

Specimen No. 19. Barite. White, tabular cleavage fragments. The cleavage pattern on one face is similar to that of calcite, two intersecting at 75°, while the pattern on the other faces is brick-like, created by two cleavages at right angles.

This phenomenon, together with the high specific gravity, readily distinguishes the mineral from calcite. Tabular crystals of the orthorhombic system are also found. Chemical composition, a barium sulphate.

Specimen No. 20. Manganite. Iron black, fibrous, with perfect cleavages. The streak varies from brown to black. Crystals are prismatic and orthorhombic. Specimens of manganite with barite and calcite are very striking. Specimens suitable for micromounts can be found. Chemical composition, hydrated manganese oxide.

Specimen No. 21. Pyrolusite. Iron-black, massive or fibrous, soft (soils the fingers). Closely resembles manganite, but differs in hardness (manganite does not rub off on the fingers). Chemical composition, manganese dioxide.

Specimen No. 22. Psilomelane. Massive, botryoidal, mammillary, or stalactic, iron-black mineral with a black streak. Often banded with fibrous pyrolusite. Its fracture is conchoidal and smooth. Hardness, that of a knife blade. Easily mistaken for hematite; the distinction is readily made, however, by the streak. Chemical composition indefinite, owing to the impurities that are almost always present; essentially it is a hydrated manganese oxide.

Specimen No. 23. Apatite. Minute, thin, hexagonal crystals scattered over the surface of hematite. The color varies from yellow to reddish. The luster is resinous. This is ideal material for micromounts. A note of warning: be sure the crystals you are calling apatite are hexagonal; adularia of the monoclinic system and dolomite of the trigonal division are found here, and are similar in color and occurrence to apatite.

Between Negaunee and Ishpeming is a knoll known as Jasper hill It is worth climbing this knoll to look at the rock and the scenery.

Specimen No. 24. Jaspilite. Brilliant, light red bands consisting of jasper, and hard, bluish-black, specular hematite. The jaspilite is folded, bent, and twisted in a most fanciful fashion. One can study many structural forms. When polished, specimens assume a very beautiful polish.

In a side trip to the north of Ishpeming near the abandoned Ropes Gold Mine and rock quarry, the following minerals can be collected:

Talc—a light green mineral, very soft and with a greasy feel.

Serpentine—similar to talc but usually much darker in color and somewhat harder.

Asbestos—short thread-like fibres in veinlets of the altered peridotite.

Verde Antique Marble—a mixture of serpentine, calcite, dolomite, and talc; when polished it is very attractive.

Traveling west on the U. S. highway, we can see mine shafts and abandoned dumps. Specimens procured from these can also be collected at the places described later.

The next stop is at a road cut at the Barron Mine. Here we have an ancient sea beach which is now standing vertical. Once this beach was almost horizontal, and the water of the sea was eroding its iron ore banks. How red its waters must have been! The present position of the beach is due to the folding of the rocks of the region. Since this formation occupies the same relative position as the conglomerate seen in North Jackson pit, it is well to take a sample.

Specimen No. 25. Metamorphosed conglomerate. Well-rounded pebbles of quartzite, with occasional slate and iron formation members. The matrix, instead of being mud or finely ground quartzite and iron formation, is composed of chlorite, mica, and specularite, all lying parallel to one another.

To the south of the abandoned Barron Mine, the following specimen can be found:

Specimen No. 26. Mica schist. A metamorphic rock with good cleavage, due to the parallelism of the mica plates. Small red garnets form knots in the rock.

We now return to U. S. 41 and go west to the next stop, Champion. From the railroad depot we follow a diagonal

street running to the southeast. At the end of this street, across a ditch, we find an outcrop. This outcrop shows volcanic breccia.

Specimen No. 27. Angular fragments of various size and composition in chloritic schist. Originally this chloritic schist was volcanic ash mixed with mud.

Returning to the railroad depot we take the street going southwest until we reach a mine location known as Beacon. At the mine dumps the following minerals can be collected.

Specimen No. 28. Martite. Iron-black, equilateral triangular crystal faces, imbedded in a soft, greenish substance—chlorite. The crystals are perfect octahedrons. Streak reddish to purplish-brown, very different from the black streak of magnetite. The mineral is not magnetic, or only feebly so. Martite is an alteration mineral; it has the chemical composition of hematite, but retains the form of the original mineral magnetite, from which it was derived.

Specimen No. 29. Garnet. Twelve-sided crystals imbedded in chlorite, each face being diamond-shaped. The faces are coated with chlorite; but when held up to the light the faces on broken surfaces appear brown or red. Garnets are very hard and will scratch glass. Chemical composition, a complex silicate of calcium, magnesium, iron, and other elements.

Specimen No. 30. Magnetite. An aggregate of black grains having a black streak. Attracted by a magnet. Chemical composition—a compound of two iron oxides, ferrous and ferric oxides. Oxygen 28%, iron 72%.

Specimen No. 31. Grunerite. White (gray), fibrous, silky needles, radiating in all directions and forming spherical aggregates. Imbedded in magnetite. Chemical composition, an iron silicate.

Specimen No. 32. Specularite. Thin parallel flakes of hematite, giving the ore its specular, tinsel-like appearance. Some of the flakes are magnetic because of the presence of magnetite.

Specimen No. 33. Chloritoid. Large, greenish, platy crystals showing one perfect cleavage. Hardness equals that of a knife blade. Distinguished from mica by hardness and brittleness Chemical composition, hydrated iron, magnesium, aluminum silicate.

Specimen No. 34. Tourmaline. Long, slender, black crystals embedded in dense white quartz. Cross-section is round or triangular, and prism faces are grooved lengthwise. Scratches glass. No streak. Chemical composition, a complex silicate, mainly a borosilicate of aluminum.

Specimen No. 35. Pyrite A pale, brassy, metallic mineral with a greenish-black streak. Tarnishes brown, but is sometimes beautifully iridescent. Cubes having faces with striations at right angles to each other are found. Chemical composition; an iron sulphide.

We return to the depot, cross the tracks, and go in a northerly direction until we come to a stop at a sharp turn in the road. The ruins of an old iron blast furnace stand at the foot of the hill.

Specimen No. 36. Black quartzite. Quartz grains well-cemented. Black coloring due to the presence of minute grains of magnetite. To the north are small mines, where many yellow, earthy, limonitic specimens can be collected.

In gathering all these specimens you must have wondered why such a large group of minerals is present in such a small locality. Why do the various different-appearing minerals have the same chemical composition? The answers to these questions are found in the geologic history of the region.

The Marquette range consists of pre-Cambrian sediments folded into a canoe-shaped basin, extending for 30 miles west of the city of Marquette. The eastern portion of this basin ends in a simple U-shaped structure, while the western end terminates in a complicated manner. To the north and south are granitic and schistose rocks. Within this trough are folds of various sizes, whose positions, although somewhat in accord with the major structure, are modified as a result of the intrusion of basic and acid igneous rocks.

In these sediments the original iron formatin was a chemical deposit composed of thin interbedded layers of siderite and chert, along with iron oxide minerals, clay, and sand. It is believed that in no place was the iron content of the iron formation high enough to be considered as ore.

After prolonged deposition, conditions changed and the iron formation was exposed to surface weathering. Thus, mainly through oxidation, the siderite was converted into hematite and goethite, and became a ferruginous chert. At exposed places the decomposition proceeded to its full extent; most of the silica was removed in solution, and a soft ore was left which consisted largely of hematite and goethite. Where the iron formation occupied low ground, oxidation occurred only slightly, leaving the formation as sideritic chert. In the meanwhile the mechanical processes of erosion rearranged the surface mantle, removing it entirely from the hills and depositing it in the valleys.

Then the region was invaded by a sea. The natural sequence of events was the deposition of gravel and sand, involving the rearrangement of portions of the surface mantle lying on the iron formation. In places the gravel was rich enough to be ore; in other places lean ore developed; and in still others, as unoxidized iron formation remained.

The gravels were covered by clays, silt, fine sand, and, in favorable spots, local bodies or iron formation. The graphitic slates in the lower members of the iron formation suggest swampy conditions—probably they were similar to the present bog ores of Sweden.

In the meantime volcanic activity interrupted the deposition, and pyroclastic (angular volcanic) material was deposited, which later was covered by sands and clay.

The next events were the folding of the region and the intrusion of basic and acid igneous rocks. These caused many changes and the formation of a new group of minerals, which depended upon the chemical composition of the material available and upon the processes involved.

Where differential pressure was the main factor (dynamic alterations), a very striking type of mineral developed, characterized by a parallel orientation which gives the rock schistosity or flow cleavage. Examples of it are the mica, chlorite, graphite, specular hematite and amphibole. The unweathered original iron formation, under dynamic influences, recrystallized to a similar rock, called cherty iron carbonate. The ferruginous chert formed jaspilite; the soft ore (earthy hematite) formed hard ore (dense specular hematite).

Where changes took place near intrusivé igneous rocks (at the contact) the original iron formation crystallized to grunerite, magnetite, a granular chert; the ferruginous chert to jaspilite; the soft ore (hematite) to hard ore (dense hematite and magnetite).

In places garnets, staurolite, and igneous-type minerals were formed. The sediments were metamorphosed to resemble igneous rocks.

A period of extensive weathering and erosion followed, exposing a part of the iron formation; in favorable places the original iron formation was concentrated into ore. Structure played the dominant part in forming ore, as is shown by the position of the commercial ores in the mines.

There are two principal types of mines, the soft ore mines and the hard ore mines. The soft ore occupies structural troughs formed in various ways, while the hard ore is prevalent as irregular pockets and sheets in the old erosional surface. These ores are responsible for the mines of today, and the mines in turn are responsible for the good roads that enable us to take this trip.

THREE CONNECTICUT LOCALITIES

By WILBUR J. ELWELL,
Danbury, Conn.

The hurricane and flood which swept over Connecticut, a few years ago, did considerable damage. Trees were blown down, houses and bridges washed away and other havoc played with the landscape. In some cases they affected mineral localities of which two instances are mentioned below.

About 1½ miles northeast from the village of Union, with its 196 people (1930) census in Tolland County, northeastern Connecticut, there was once the attractive Bigelow Pond just north of Conn. Route 198. Just west of the south end of this pond were exposures of Precambrian schists, the oldest rocks in Connecticut. In the road cut through these schists iolite crystals of excellent color had been found.

T. Lipton Smith and I set out one day to find this locality. We stopped at a garage in the neighborhood to inquire directions and learned for the first time that Bigelow Pond was no more—it went out with the flood when the dam gave way. As for the road cut, one of the garagemen said it must be the spot where a Chinaman was seen last summer reading a bible. (I suspect he was a Chinese student with a Dana who was also looking for minerals). We found the locality without further trouble and collected garnets, iolite and moonstone. Bigelow Pond is no more—it is now a brook!

At West Stafford, Conn., also in Tolland County, there is a quartz crystal locality known as "Diamond Ledge", which is ¾ of a mile north from the main road. Diamond Ledge Brook crosses the road (Conn. 15) in West Stafford and it is marked with a sign. This locality was somewhat inaccessible due to many large pine trees growing on the site. The hurricane, however, blew them all down and a portable sawmill cut them up into boards. Furthermore a new wood road follows the brook to the locality. The ledge is now an open spot with no trees and easily reached. But do not take your car up this road; walk to the locality as the distance is a short one from Route 15. We found quite a few groups of good quartz crystals.

The siderite or spathic iron ore mine at Roxbury Station in southern Litchfield county, western Connecticut, was opened up about 150 years ago. The ore is of an extra good grade but no data is available on how much had been mined. The main tunnel runs about a mile into the mountain, called Mine Hill. The mine has been abandoned for about 70 years. A narrow gauge railroad used to bring the ore down from the mine, at the top of the mountain, to the smelting furnace at the foot. About half way down the railroad made a sharp right turn. It is said that one of the miners, John Healey by name, boasted he could take one-half load of ore and ride it to the smelter without using any brakes. He tried this one day and when he came to the sharp curve the car jumped the track and wedged itself against a tree—the front axle practically encircled the tree—and was a complete loss. Healey was killed. Most of the miners in those days belonged to the old labor union called the "Knights of Labor."

Bill Beardsley and Bill Weller, two men who used to work at the mine, told me many years ago how lightning used to hit the mountain and that it killed two horses and a man. I wonder if the ore attracted the lightning!

I understand that some of the largest mines are using a chemical that "smells like a skunk" which is placed in the air to warn miners when danger is present. Perhaps some of you collectors who live in a city do not know how a skunk smells. If you are curious to know, drop a card to T. Lipton Smith. I think he can tell you about it. Lipton and his dog met a skunk last fall while out hunting!

GEOLOGY OF THE UNDER-RIVER SECTION OF THE QUEENS MIDTOWN TUNNEL

By THOMAS W. FLUHR

The writer, who has been associated with Dr. Charles P. Berkey on geologic work connected with many major engineering projects, has found the Queens Midtown Tunnel one of the most interesting. This is a tunnel thirty-one feet in diameter constructed by the New York City Tunnel Authority as a highway for vehicular traffic crossing the East River between midtown Manhattan and Queens. The under-river section was excavated by the use of shields and compressed air. The contract work on the under-river section was carried on by the Walsh Construction Co. of which Mr. John S. Macdonald is Chief Engineer. The tunnel was designed and construction supervised by the New York City Tunnel Authority, of which Mr. Ole Singstad is Chief Engineer, Mr. Wm. McKenna Griffin, Deputy Chief Engineer, Mr. James Dugan, Engineer of Design, and Mr. Jacob, Mechanic Engineer of Construction. Dr. Charles F. Berkey acted as Consulting Geologist.

Exploratory investigations of the tunnel line were made by diamond drill borings and preliminary geologic sections drawn prior to design of the tunnel. As excavation progressed the geologic features were recorded and are presented here as a factual record of interest to engineers and geologists.

The rock floor at the Manhattan and Queens ends of the tunnel is high. This made it possible to sink construction shafts into bed-rock at each end of the under-river section, and to start the tunnel shields in rock. In the middle of the river, also, the rock floor is high, permitting some of the excavation to be carried on by rock tunnel methods.

In the west channel of the river, on the other hand, the rock floor is low, dipping in part below the bottom of the tunnel. In the east channel are two low spots where the bed-rock drops below the bottom of the tunnel, split by a low dividing ridge where the rock reaches only a short distance above the tunnel roof.

These changes in elevation of the bed-rock floor are the natural accompaniment of the geologic structure. The rock formations at the Manhattan end, in the center of the river, and at the Queens end of the tunnel, are all hard rock. At the Manhattan end is Manhattan Schist, a strongly foliated micaceous rock which underlies most of Manhattan Island. In the center of the river is Fordham Gneiss, which form Welfare Island and its associated reefs. In Queens there is the resistant Brooklyn Injection Gneiss. In the channels the rock is softer and less resistant to weathering. Beneath the west channel is a belt of Inwood Limestone; beneath the east channel lies the Hell Gate Dolomite. At a time long before the Glacial ice sheet swept over this part of the country, when the land stood higher above sea level than it does today, rivers and streams ran over that land surface and cut valleys down into it. Naturally these rivers and streams found it easier to follow the belts of weaker, less-resistant rocks, and thus the present east and west channels of the East River were formed. At a later time glacial debris partly filled these channels. In fact a short distance farther south the channels are entirely filled and the river displaced from its former course. The trend of the belts of the folded rock formations is northeast-southwest, and therefore the valleys and ridges follow the same direction.

The bed-rock formations are of several kinds. The oldest, which was formed and recrystallized before the others were laid down, is the Fordham Gneiss. Originally it appears to have been a series of sediments which were folded and metamorphosed. As found in the tunnel, it is usually a black and white banded rock, the light bands being quartzose and

feldspathic, while the dark bands are biotitic and hornblendic. In many places this gneiss has been heavily granitized. Occasionally interbedded limestones are found in the Fordham Gneiss formation, one of which was encountered on the west side of the reef in the river, while the Hell Gate Dolomite itself is considered by some geologists to be one of the larger interbedded limestone members of the gneiss formation.

The Brooklyn Injection Gneiss, found at the Queens end of the tunnel, is related to the Fordham Gneiss formation. In fact, it has been made from the gneiss by the intrusion of an igneous rock known as the Ravenswood Granodiorite. This igneous rock has soaked up into the Fordham, partly replacing it, and forming mixed rocks, in part gneiss, and in part granodiorite, which are known as the Brooklyn Injection Gneiss formation. Some of the structural characteristics of the Brooklyn Injection Gneiss appear to be due to the intrusion of the granodiorite melt into the Fordham.

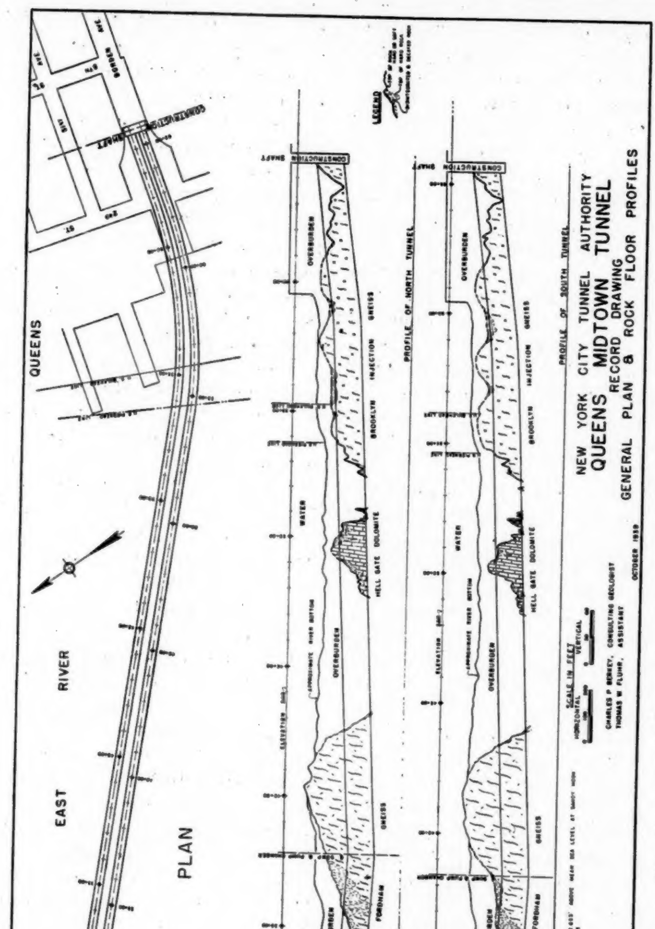
After the original Fordham deposits had been laid down, folded, and recrystallized into a gneiss, a limestone was deposited on top. Then above the limestone, a series of silts and muds were laid down. These, with the underlying Fordham, were folded, intruded, and injected by material of igneous origin, and the upper sediments recrystallized into what are now called the Inwood Limestone and the Manhattan Schist. These formations were folded, with the axes of folding trending northeast-southwest. The folding was intense, and the formations were tilted steeply on edge. Erosion then planed off the arches, leaving exposed the upturned edges of the beds, which are found now as long narrow belts with a northeast-southwest trend. A continuance of erosion formed valleys along the limestone belts, while the harder formations remained as ridges.

At many places along the line of the tunnels the upper portion of the rock floor showed deep weathering and decay. The decay and disintegration effects were not uniform, bands of hard rock frequently alternating with bands of soft rock. The Glacial ice sheet which pushed down over this area undoubtedly scoured off most of the softened and weathered original surface of the bed-rock in Queens and Manhattan, but apparently rode over some of the river valleys and channels, leaving part of the weathered rock untouched.

The Manhattan Schist found at the Manhattan end of the tunnel is a quartzose schist carrying garnet and injected by pegmatite. Its general strike is N35E with a dip of 3ONW. In the Manhattan ventilation and construction shafts the quality of rock was good. Full size tunnels were excavated eastward from these shafts by ordinary rock tunnel methods, and the rock was sufficiently good to stand without support until the tunnels had approached near to the edge of the river. Then the schist became jointed, and test holes driven ahead indicated the presence of soft ground. This was in agreement with the results of exploratory borings made prior to the start of tunneling, which had shown the presence of a fault and crush zone. On approach to this fault, full size tunnel excavation was suspended and further progress made by driving bottom drifts.

The crush and decay zone of this fault proved to be about twenty feet wide at the roofs of the tunnels and much narrower at the bottom. The displacement is a normal fault in which the east side has moved downward in respect to the west side. The crushed schist in the fault zone has decayed to a chloritic sand, which fortunately, was comparatively dry and did not run. Bottom drifts were driven through the zone, the crushed and decayed material being supported by liner plates, and were advanced until pilot holes indicated a rapid drop in elevation of the rock floor. Excavation of the bottom drifts was then stopped, and further progress made by the use of shields.

In the tunnels driven eastward from Manhattan, the north tunnel encountered soft ground in the roof at Station 28+45 and from that point eastward the rock



Plan and rock floor profiles of Queens Midtown Tunnel, the new vehicular highway extending from Manhattan Island to Long Island (Queens), under the East River, New York City.

floor dropped rapidly in elevation, with an exceedingly irregular rock floor profile, the schist finally disappearing at Station 30+18. In the south tunnel, soft ground was first encountered at Station 29+15. Here also the schist dropped off rapidly in elevation, finally disappearing at Station 30+68. In both north and south tunnels there was a considerable thickness of disintegrated and decayed schist lying above the hard rock.

The Inwood Limestone formation was encountered in the north tunnel at Station 31+37 and in the south tunnel at Station 32+11. Most of this was soft, chloritic, and badly disintegrated. Only a few feet of hard white crystalline Inwood Limestone was encountered in each tunnel, immediately adjacent to the Fordham Gneiss.

The Fordham Gneiss formation was first encountered in the north tunnel at Station 32+12 and in the south tunnel at Station 33+48. Most of this was a hard biotitic gneiss. A large interbedded limestone band found in the gneiss, extended from Station 33+53 to Station 34+30 in the north tunnel, and from Station 34+45 to Station 34+95 in the south tunnel. The profile of the gneiss on the west side of the reef in the river is very irregular and there was a considerable thickness of weathered rock. This proved to be of great importance for the tunnel encountered a greater amount of disintegrated and decayed rock in the roof than had been anticipated. On the east side of the reef of Fordham Gneiss, on the contrary, the rock profile was found to be regular, there was no deep cover of disintegrated rock, and the tunnel entered into the hard rock where expected. This difference in behavior results from differences in erosion in consequence of the dip of the formation being to the northwest. The Fordham Gneiss in general, is good rock for tunneling, and once the shields had entered the hard rock of the reef, further excavation was hastened by means of drifts in free air.

The strike of the foliation structure of the Fordham Gneiss is almost at right angles to the line of the tunnels, and the dip varies from 20NW to 70NW with an average dip of 60NW. This rock structure is favorable for tunneling and the rock stood up well. Frequent joints followed the foliation, many of which carried small quantities of water.

A fault was encountered in the north tunnel at Station 38+00, continuing into the south tunnel where it finally disappeared at Station 40+46. This was a minor cross fault marked by a narrow crush zone. In ordinary tunneling operations but little attention would have been paid to it, but here, with the river only a short distance overhead, it assumed more importance. Exploratory borings were made from the tunnels through the fault, and for a distance beyond. Grouting was carried on through these exploratory borings and through drill holes. The shields were advanced and the fault zone penetrated with their protection. The zone proved to be only a few feet wide and not badly decayed.

The Hell Gate Dolomite forms a reef in the east channel of the river, but only a little of it was present as fullface rock excavation in the tunnels. Most of the dolomite is soft and decayed. This decay was especially marked on the east side of the reef, where it was difficult to draw a distinction between the residue of decayed dolomite in its original position and that transported a short distance and laid down as a sedimentary deposit of "blue clay." Where not decayed the Hell Gate Dolomite is indistinguishable lithologically from the Inwood Limestone.

The Brooklyn Injection Gneiss found at the Queens end of the tunnel shows considerable variation in type. It is represented by many kinds of rock, from well-banded biotitic and hornblendic gneiss to rather massive granodiorite. Occasional limestone bands also were found in it. In general this rock stood up well when the tunnel drifts were driven through it, requiring practically no support. There were occasional joints, but most were tight and but few carried water. Practically no shear or crush zones were

found in this rock formation and very little disintegrated or decayed rock was present.

Two major types of unconsolidated material were found above the rock floor; *Artificial Fill,* and *Glacial* Deposits. In addition to these there was a limited amount of material which is older than the others,—the *Blue Clay.*

The *Blue Clay* lies immediately above the rock on the east side of the ridge of Hell Gate Dolomite found in the east channel of the river. It is judged to be pre-Glacial in age since the glacial deposits overlie it. The deposit is a rather homogeneous sandy clay. Most of it is light blue in color, but brown, reddish, green, and white layers are present. Sand layers without clay are found in it, and some of these sand layers carry rounded pebbbles, thus proving that this deposit is of fluviatile origin. It undoubtedly has originated from the decay and disintegration of the adjacent Hell Gate Dolomite and has not been transported far from its source.

Above the blue clay, and found only in a few places, particularly on the Queens side of the tunnel, is *Glacial Till.* This lies beneath modified glacial drift and occasionally grades into it. This till is made up of sand, clay, and gravel, with many boulders, and shows no stratification.

Overlying the glacial till are deposits of *Modified Glacial Drift.* This term usually includes any water-laid glacial deposits, but for convenience in classification and representation on geologic sections, the use of the term was limited on this project to the coarser deposits. This material is stratified and consists of sand and gravel with occasional boulders. It carries little or no clay.

Above the modified glacial drift are *Glacial Lake* or *Estuarine Deposits* consisting of alternating thin horizontally bedded layers of gray silt and red clay. This material is known to the sandhogs as "Bulls Liver." These are quiet water deposits laid down either in lakes or in an estuary. In the east channel of the river, in addition to the gray silt-red clay layers, there was a considerable thickness of gray sand underlain and overlain by the finer gray silt-red clay deposits.

The glacial lake deposits in this area are the latest of the glacial deposits and are overlain by deposits of recent origin. The present East River has deposited a little sand and gravel but most of the recent deposits are of man-made origin, and are those known as *Artificial Fill.* Some of it consists of sand and gravel, some of it is coal from sunken barges, but the most important part of the fill is a large accumulation of rip-rap found near the Manhattan bulkhead. This consists of irregular fragments of broken stone in large and small blocks. The blocks are mostly of Manhattan Schist type. This makes a very pervious material, the interstices between the blocks being open, with practically no sand filling. Excavation was difficult through the rip-rap. It was found in the upper part of the tunnels where there was already an unbalanced outward pressure of air. The lack of material in the interstices between the blocks of rock left voids, and removal of a block resulted in an immediate outrush of air, necessitating constant use of sawdust, salt hay, and clay to stop the blows. Even a clay blanket laid down in the bed of the river above the tunnel did not stop the blows, for the air found its way through the rip-rap to the edges of the blanket where it could escape. Excavation through this rip-rap was the most difficult part of the tunneling. Eventually wash borings were made into the rip-rap from the surface of the river in advance of the shields, and grouted with a variety of lime cement.

In excavating through soft ground compressed air was used at pressures ranging up to 37½ lb. per sq. in. It was usually necessary to keep the air pressure somewhere near the theoretical amount, balancing the hydrostatic head a little below the mid-point of the face of the excavation. The material encountered was never sufficiently impervious to permit working with a great reduction in air pressure. None of the soft ground was

sufficiently fluid to be displaced, the shields could not be shoved blind, and it was necessary to excavate practically all the material ahead of the shields.

It was recognized from the inception of this project that it was a task involving extreme difficulties. That these difficulties were surmounted is due to careful planning and painstaking methods of construction. In view of the expected difficulties, the exploratory work carried on in advance of construction was more thorough than on any previous undertaking of this kind in the metropolitan area.

With the aid of the engineering staff a complete and accurate record was made of the various type of material encountered during excavation, and the data recorded on geologic sections to the scale of one inch equal to ten feet.

A plan and generalized rock floor profile show in graphic form some of the subsurface geologic conditions.

TOE RIVER FAIR

The 27th Annual Toe River Fair, devoted to the betterment of education, agriculture, industry and the home in Yancey, Avery and Mitchell Counties, North Carolina, will be held September 10, 11, 12, 13, 14, 1940, at Spruce Pine. This year the Fair is attempting to put on exhibit the largest and finest assortment of North Carolina minerals and mineral products that has ever been shown in that section. Bradley Johnson, a member of the Rocks and Minerals Association and one of the best known and most popular mineralogist in the South, will be in charge of the mineral exhibit.

A special invitation is extended to all members of the Association to attend the Fair and inspect the mineral exhibit. Complimentary tickets for entrance to the Fair grounds will be forwarded to all members who will send a self-addressed stamped envelope to Mr. Johnson. (For quick response address all letters to Mr. Bradley Johnson, Penland, N. C.)

Mr. Johnson suggests that out-of-state members and visitors should plan to visit the Fair on its last day—Sept. 14th—so that they could all get together afterwards, talk minerals, and have a field trip on the following day.

Those of our members who may be interested in the Fair, which will be held in one of the country's greatest mineral localities, Spruce Pine, N. C., and who may plan to attend it, should drop Mr. Johnson a card informing him of their decision.

Mastodon Skull Added to Museum's Exhibit

The skull of a four-tusked mastodon from Pliocene deposits of Nebraska has been added to the paleontological exhibits at Field Museum of Natural History, Chicago, Ill.

"Four-tusked mastodons, like other members of the elephant order, were immigrants from Asia, and reached North America by way of a land bridge across Bering Strait", states Elmer S. Riggs, curator of paleontology. "They appeared suddenly, about 8,000,000 years ago, in considerable numbers on the plains of Nebraska and Kansas, and were doubtless distributed over a large part of this continent. The four-tusked species was a large-headed one which stood about eight and one-half feet in height."

PERPETUAL ICE CAVES OF NEW MEXICO

By CLARK HARRISON

Back in May we were driving through Grants, New Mexico—just west of Gallup. Having heard much about ice forming out in the hot desert near there, we decided to investigate. Leaving Highway 66 (which is a good paved road from Los Angeles to Chicago), we drove up a good dirt road to Flagpole Crater, 27 miles away.

Most of the way we skirted a valley filled in most places with altering black lava. The mountainous country abounds in pine forests, and deer are plentiful. This lava flow is considered the largest in the world—covering 20 by 40 miles of the valley.

At the foot of the crater (elevation about 7400 feet) we were surprised to see, nestled in the pines, a small resort, with cabins, restaurant, stores, and bar open to the public. The crater appears to be about 600 feet high, and the top may be reached by foot or horseback.

A block from the resort we came onto the largest ice cave. The black lava has caved in or sank to a depth of some 25 feet at this point. At the end of the sunken pit next to the crater (about a quarter mile away) is a cave about 6 feet high leading back into lava. At the mouth of the cave is a huge wall of ice —about 30 feet long, 12 feet high and at least 5 feet thick, splotched unevenly with apple-green color, with veins indicating that it might have formed layer upon layer. The floor is of smooth glistenings ice of unknown depth. The cave contains no ice, once one gets back inside away from the entrance.

Wooden stairs have been built down to the ice. Half way down one may feel a sharply defined zone—hot on one side, cold on the other. The day we were up there it was 95°F outside and only 29°F at the mouth of the cave. We were told that it remains 29°F down there the year round. In mornings the sun shines on the ice.

There are other ice caves in the vicinity. A small one near the resort is often used in the summer to store meat and other perishables. Another cave two miles away contains stalactites and stalagmites of ice; and in some instances, the stalagmites are capped with knobs of ice. Quite a distance has been explored in this cave, some 7 miles having been traversed, but no end found.

No wild life exists in the hot, dry lava beds today. Snakes find the abrasive lava too hard to travel over, and rodents tire of dulling their claws trying to dig holes. However, soon after this crater became extinct (about 1000 to 2000 years ago) Indians began living in the lava beds here, as is evidenced by rooms, fences, stables, etc., they built, and which one may see scattered here and there. In the surrounding country many Navajos live, many over a hundred years old. They tell traditional stories.

No minerals exist in the lava of course. But in the surrounding country coal, iron, copper, silver and gold are found.

Inquiry failed to provide an explanation as to the way this ice forms, or why it doesn't melt away in the summer heat. Carbon dioxide under pressure forms ice upon striking air. Could it be possible that the secret lies in the fumes and gases that may be escaping from or through crevices from the crater? Possibly someone has found the answer. We would like to know.

Naturalist's Directory

The 32nd biennial edition of *The Naturalist's Directory* will be pubished in September. This Directory comprises the names, addresses and special subjects of interest of naturalists in all parts of North and South America as well as a listing of scientific periodicals and natural history museums. The price is $2.50 and it is published by the Naturalist's Directory, Salem, Mass.

OUTLOOK FOR FINDING DOMESTIC DEPOSITS OF STRATEGIC MINERALS MORE ENCOURAGING THAN ANTICIPATED ACCORDING TO BUREAU OF MINES

With the national defense program swinging into action, the Bureau of Mines on June 6, 1940, reported to Secretary of the Interior, Harold L. Ickes, on results of the first nine months of the strategic minerals survey being conducted jointly by it and the Geological Survey.

Although the United States is far from self-sufficient in strategic minerals, the general outlook for locating important domestic deposits is definitely more encouraging than anticipated at the start of the search. Dr. R. R. Sayers, Acting Director of the Bureau of Mines, said that the situation with regard to five minerals—essential in peace and critical in war—is somewhat promising. These minerals are manganese, chromite, tungsten, mercury, and antimony. The nickel situation, he said, is less encouraging and results in tin are classed as rather negative.

The importance of locating and developing useful deposits of the major strategic minerals is shown by the heavy percentages of these minerals which must be imported at the present time. The following table, according to the Bureau of Mines, shows the percentage of the nation's peacetime requirements produced from domestic mines during a recent five-year period:

Manganese	5-6	percent
Chromium	1	"
Mercury	40	"
Tungsten	50	"
Nickel	.5	"
Tin	.2	"
Antimony	10	"

Field examinations have been made during the survey of 162 deposits of strategic minerals brought to the attention of the Bureau of Mines from various sources. Of these, 33 are considered to be of sufficient interest, from the viewpoint of constituting possible strategic reserves, to warrant some exploratory work involving sampling by trenching, tunneling, test-pitting, or diamond drilling or by a combination of these methods. In addition, about 250 deposits, among several times that number on which some information has been obtained, are considered to be of enough interest to warrant preliminary examination.

Actual exploratory work has been conducted by the Bureau on 9 different projects, of which one is an antimony deposit in Idaho, three are chromite deposits in Montana, Wyoming and Oregon, one is manganese in Washington, one nickel in Nevada, two tin in South Dakota and New Mexico, and one tungsten in Nevada. The results have been sufficiently encouraging to warrant further work on six of these projects, and on four of them this further work is now being done or is being planned. This exploratory work is being conducted by a staff of mining engineers under the supervision of Charles F. Jackson, chief of the Bureau's mining division.

In all of the projects examined by the Bureau of Mines, some new ore bodies were found, though they were not generally of commercial grade. It is pointed out, however, that, for availability as strategic reserves, it is not essential that deposits be of commercial grade.

On manganese, the most important of the strategic minerals, mainly because of its vital role in the making of steel, actual exploratory work was done only in one locality, for the reason that there were so many manganese deposits to be considered that the most promising ones could not be selected immediately. It has now been possible to select from the manganese deposits considered 47 that warrant exploratory work, and during the next fiscal year it is proposed to give precedence to the exploring of manganese deposits. The nation's reserves of low-

grade manganese deposits are large; the problem being the devising of metallurgical processes that may make some of these low-grade reserves available for strategic demand.

One small lens of high-grade manganese ore was discovered which will not add to the strategic reserves, because it is of such grade and quality that it probably will be quickly mined out and the ore sold at a profit. Of interest, however, is the fact that the drilling cost was only about $1 per ton of ore indicated, the value of which is $30 per ton or more at prevailing prices.

Imports of manganese ore in the past have been mainly from Russia, Cuba, the African Gold Coast and Brazil.

Extensive deposits of chromite of a grade that could probably be used in an emergency are indicated in one locality. Further exploratory work by trenching and diamond drilling was resumed early in June for the purpose of definitely proving the existence of sufficient tonnage to be of real strategic importance. Metallurgical investigations on this ore, which is not up to standard grade, indicate that a high-grade ferrochrome product can be made, though at a cost somewhat above the normal price of this alloy. Chromite has various important chemical uses and is also used as a refractory. Ferrochrome is used in making special varieties of steel. Imports have been largely from Southern Rhodesia, Union of South Africa, Philippine Islands, Turkey, and New Caledonia.

A large low-grade deposit of antimony ore has been indicated by diamond drilling. Although sub-commercial in grade, this deposit could furnish a substantial percentage of our requirements in an emergency at a price considerably above the prevailing one. Some high-grade antimony ore has been discovered occurring in small lenses and it is believed that, in the general area in which they occur, there are enough of these small deposits that in the aggregate they would constitute an important reserve. For military purposes, antimony combined with lead is used to make bullets. Antimonial lead is used as type and bearing metals. The greater part of our antimony imports prior to 1931 came from China; since that date Mexico has become the principal source of imports.

The outlook for the United States becoming self-sufficient in tungsten is very good, largely as the result of the efforts of private enterprise. The greatest use of tungsten is in making high-speed tool steel.

In the case of mercury, the prevailing high price has stimulated production from lower-grade domestic deposits the last few months to a production rate equal to the requirements of industry, although the length of time this rate of production can be continued is problematical. Mercury is used in the manufacture of fulminate, for detonating high explosives and fixed ammunition, for gold recovery by amalgamation, in drugs, dental amalgam, and for other purposes.

Two or three nickel-bearing deposits were discovered that are of sufficient promise to warrant exploratory work and sampling. Nickel is largely used in the production of alloy steel and in the making of various important alloys. The great bulk of production is from Canadian deposits.

As in the past, tin reserves have not been evidenced. It would be impossible to produce any large amount of tin even from the low-grade ores found. One small ore shoot was partially delineated to a depth of about 300 feet and found to contain enough tin so that it could be worked at prices about double the prevailing market price. There might be a considerable amount of similar material at depths below that which was prospected. The United States normally consumes about 75,000 tons of metallic tin or half of the world's supply. Of this, about 40 percent is used in making tinplate, 30 percent as solder and bearing-metals, and the remainder as foil and in miscellaneous ways. In recent years, about 75 percent of the world's supply of tin has been derived from placer deposits in the Malay States and the Dutch East Indies. *(Continued on page 314)*

ICELAND SPAR

By E. V. VAN AMRINGE

Iceland spar is a colorless, transparent variety of calcite showing strong double refraction, hence its German name, "Dopplespath." True optically clear calcite has always been scarce and in considerable demand, and any occurrence yielding specimens of commercial size is not only of scientific but of economic importance. At the present time South Africa furnishes most of the material, mainly from the Kenhardt district in the northwest portion of Cape Province. A very small additional supply comes from northern Spain. Other localities which show promise of future production are notably in British Columbia (north of Ferguson) and in several of our western states.

The deposits near Greycliffe, Montana, seventy miles west of Billings, are very extensive and insure a domestic supply if foreign sources are ever closed. The product is too highly cleaved, however, to compete in the present market. Small deposits of good material are known in Harney County, Oregon, and from near Pyramid Lake, Nevada.

California has a number of potentially important occurrences, particularly those in Modoc and Mono counties, with small amounts in Cave Canyon, east of Yermo (San Bernardino Co.), east of Alberhiil (Riverside Co.), west of Truckhaven (Imperial Co.), and a few miles west of Darwin on State Highway 190 (Inyo Co.). The best known locality was that in the Warner Range, near Cedarville, Modoc County, where quite a large amount of high grade spar was produced between 1920 and 1923. The deposit seems to be exhausted. The Mono County material occurs on the west and south slopes of Mount Baldwin (elev. 12,595 ft.) on the steep eastern face of the Sierra Nevada, 28 miles airline northwest of Bishop and 10 miles southeast of Mammoth. The region is near the headwaters of Convict Creek, all above two miles in elevation and nearly inaccessible. Convict Creek was named from the famous prison break at Carson City on Sept. 17, 1871, when twenty-nine escaped. A posse from Aurora and Benton led by Robert Morrison cornerd three of them not far from the location of the spar deposit. In the resulting gun battle, Morrison was killed and the convicts captured after further pursuit into Round Valley. Two were lynched at Bishop, and the third returned to prison. The ruggedness of the region is illustrated by the nearby Bloody Canyon, so named from the effects of the sharp rocks on the legs of unfortunate pack animals during a gold rush in 1858. The calcite occurs in marble associated with other metamorphosed sediments of marine origin and of lower Paleozoic age. These have an almost vertical dip, and strike about parallel to the general alignment of the range, forming a long narrow zone between granitic intrusions. The Iceland spar masses are lens shaped, with crystals of enormous size yielding cleavages up to a foot in diameter, and the quality is on a par with the original Iceland material.

An interesting occurrence of Iceland spar, recently opened up in New Mexico, and known as the Iceberg Lode Mining Claim, is located in Sec. 31, T. 23 N., R. 11E., Taos County, at the southern end of the old Copper Mountain Mining district, not far from the old Lithia deposits of Harding. The deposit is about 30 miles S.-S.W. of Taos by road and approximately 55 miles N.N.E. of Santa Fe. The operators are E. M. Stanton and J. W. McCoy of Santa Fe, N. Mexico.[1] The deposit is described in more detail by Kelley.[2]

1 Iceland Spar in Taos County, New Mexico, by J. Harlan Johnson; Am. Min., Feb. 1940, Vol. 25, No. 2, pp. 151-152.
2 Iceland Spar in New Mexico, by Vincent C. Kelley; Am. Min., May 1940, Vol. 25, pp. 357-367.

Twenty-five years ago production from the classic Iceland locality dominated the market, but since the World War the quality has deteriorated greatly. Development began in 1850 and has been entirely controlled by the government since 1879. Open-pit methods were used, although, to preserve the quality of the delicate material, underground development would have been far preferable. During the War the pit was allowed to fill with water to protect the exposed material from weathering. In 19 9 it was 100 feet long, 72 feet wide at the top and 55 feet at the bottom, and 52 feet deep. The original discovery of this interesting material was made early in the seventeenth century in a stream bed at an elevation of 345 ft., west of Eskifjordur, a small seaport on the east coast of Iceland. It came from cavities in basaltic lava, where it occurred as pure crystallized masses and enormous crystals up to a yard across. One single rhombohedron was over six yards long and three high. The crystal faces were usually dull and corroded, or coated with stilbite. The mineral attracted little attention until the publication in 1669 of the book "Experimenta Crystalli Islandici" by the Dane, Erasmus Bartolinus, in which he describes his discovery the previous year of the remarkable cleavage and double refraction of the mineral. Twenty years later the Hollander, Christian Huygens, extending the work of Bartolinus, recognized polarization by refraction and formulated the laws of double refraction, a phenomenon which could not be explained by the then popular "corpuscular" theory of light developed by Newton, but which later proved quite in accord with Huygen's "undulation" theory. These and later researches paved the way for the discovery by Etienne Louis Malus of Paris in 1808 of the polarization of light by reflection, and the design twenty years later of the famous prism of William Nicol of Edinburgh. This prism is an essential part of practically every optical instrument utilizing polarized light, such as petrographic microscopes, dichroscopes, polariscopes, photometers, colorimeters, saccharimeters, etc.

A ray of ordinary light vibrates in all directions, but after passing through a cleavage rhomb of calcite, it is broken up into two rays, known as the ordinary and the extraordinary, each vibrating in a single plane at right angles to the other, and each possessing a different index of refraction. This results in their following different paths through the mineral, and in the production of two images—the phenomena of double refraction. Pure plane-polarized light is produced by use of the Nicol prism. In this, the ordinary ray is caused to be reflected and totally absorbed within the prism, and the extraordinary ray emerges vibrating in one plane only. The prism is prepared from a cleavage rhomb of Iceland spar about three times as long as it is wide. The natural faces of the elongated ends, which make angles of 109°7′ and 70°53′ with the prism edges, are ground down until the angles are 112° and 68° respectively. Then the prism is cut diagonally across in a plane perpendicular to the new faces, and parallel to their long diagonals. The cut starts from the low obtuse angle on one end face and ends at the corresponding point on the opposite end face. Great care must be taken not to allow much of sharp corners to cleave off. The cut faces and ends are then highly polished, a delicate task in view of the softness of the mineral, and the two diagonal pieces cemented together in their original position with Canada balsam. The prism faces are then coated with black lacquer, and the whole usually mounted in cork in a metal tube.

NEW ENGLAND NOTES

Conducted by RUDOLF C. B. BARTSCH
36 Harrison St., Brookline, Mass.

Middletown, Conn. On the grounds of the State Institution on Silver Street, there is located an old silver mine. A recent visit to the locality showed that there is a small crushing plant getting out road material. A quartz vein cutting through this rock contains considerable galena and many cavities with quartz crystals, small and quite opaque. In the floor of the quarry there is a much larger vein of opaque milky-white quartz. This quartz is in radiating groups of crystals some over 2 inches long.

Across the road from this locality, along the brook, it is said that fair specimens of anglesite may be found coating the stream boulders. However, we had no time to try out this lead so cannot vouch for the correctness of this possibility.

Salem, Mass. A recent visit to the trap rock quarry near the city stadium brought to light some interesting material. There are a number of veins of quartz with dolomite cutting horizontally across the back wall of the quarry. These veins contain numerous cavities and many excellent groups of dolomite crystals on a quartz base, mostly radiating groups of crystals, were found. A number of these cavities also contained numerous individual pyrite crystals. These pyrite crystals are to a large extent beautifully tarnished and iridescent and are very perfectly crystallized. Some are true cubes and many are cubes modified by the octahedron. In some sections of these veins the pyrite and dolomite are completely altered to limonite giving interesting groups of crystals with masses of limonite between the transparent quartz crystals. No arfvedsonite or nephelite of specimen quality was observed. A large amount of epidote in micro crystals was noticed. Some white calcite, but not crystals, was also present. One specimen with galena was taken.

Lonsdale, R. I. The Harris lime quarry is an open pit worked for commercial lime. At times, excellent specimens of dolomite crystals may be secured. Many interesting groups of calcite crystals are found in cavities, some delicately stained with limonite, others perfectly clear white (Iceland spar) of the rhombohedral and scalenohedron crystallization. Pure white talc may also be obtained in very fine specimens. At times quartz veins are crossed containing excellent crystals of fair size. In the schist wall, pyrite cubes are scattered plentifully making interesting specimens. A massive dolomite of a pinkish color may also be found.

Cumberland, R. I. The old copper mine dumps at Copper Mine Hill at the present time yields very little in the way of mineral specimens. Poor material of malachite, azurite, chalcopyrite, bornite, magnetite, and some molybdenite may be found. Better specimens of malachite and azurite can be found in the wall of the trap quarry near by.

The two day field trip of the Boston Mineral Club to Mt. Newry and Black Mt., Maine, was officially canceled. However, this did not stop two groups from making the trip, and securing many fine specimens.

Mt. Newry, Me. The old dumps on the top have been combed over rather thoroughly this spring as seen by the deep holes which had been dug all over the area from top to bottom. However, there still are some excellent tourmaline groups to be found, particularly the green colored ones. The new and lower working is in active operation and here better material may be secured. Triphylite, coated with blue vivianite, is very plentiful as many large veins cut through the feldspar. Over these veins of triphylite are veins of purpurite and muscovite. This material is also very plentiful but of a very fragile nature. Some excellent tourmalines were found on this dump of a blue-black color. The writer was fortunate in securing a small group of rose quartz crystals in a cavity in feldspar. An excellent terminated crystal of spodumene, 4″ wide by 12″ long and 2½″ thick with very well developed faces was also secured. There is an excellent spring in the rear of the cabin near the top of Mt. Newry where parched collectors can refresh themselves.

Black Mt. Me. The quarry at the top of this mountain is in active operation, Sundays included, due to the great demand for mica. Excellent specimens of cassiterite and manganocolumbite may be secured. The better specimens of tourmaline and lepidolite are taken by the quarrymen so they are not easily found on the dumps except as weathered material. Autunite and gummite can be occasionally found but only as inferior specimens.

North Groton, N. H. Much interesting but for the most part not very showy material may be secured at the old mica workings at this locality. These old quarries noted for their rather rare phosphate minerals such as heterosite, sicklerite, triphylite, lazulite, dufrenite, and the rarest of all the famous graft-

onite. The contact between these various phosphates is similar to that at the Center Stratford, N. H., locality. The triphylite comes first, then the sicklerite, later the heterosite, and the final alteration product, dufrenite. The graftonite is found in layers between bands of heterosite. The lazulite is of a rich blue color and excellent specimens are available with a little hard work. Beryls of rich blue and golden colors may be found. The dumps are extensive and have only partially been worked over.

Springfield, N. H. The abandoned mica workings of this locality are also collector's spots. However, the phosphates are missing. Excellent specimens of massive, solid loellingite are available on the dumps. Blue etched topaz, similar to the famous Topsham, Me., material, has recently been found. Rose quartz of fair color and quality is available at this place. One very nice quartz crystal with a phantom of smoky quartz was raked out of the dump. Fine groups of albite crystals in cavities are quite abundant.

Topsham, Me. A recent visit to the famous Fisher Quarry resulted in the additions of some very interesting material to the writer's collection. A small but beautiful specimen of white, etched topaz with some green microlite crystals and some quartz crystals was found on the dump near the famous Harvard find.[1] Many fine groups of albite crystals in cavities were also removed from the side walls of the quarry. One rather nice specimen of black quartz and muscovite with black sphalerite crystals and garnet crystals was also found on the dumps. Some cavities containing fine groups of sericite crystals with small gemmy crystals of green tourmaline were also secured.

A heavy thunder shower spoiled the collecting during the afternoon so that only a small part of the locality was actually examined. The locality is well worth visiting as we believe it has more than ordinary possibilities for the collector.

1 *Topaz and Herderite at Topsham, Me,* by B. B. Burbank. Rocks and Minerals, Sept. 1934, pp. 125-131.

Titanite Near Croton Falls, N. Y.

On the dumps of Aqueduct Shaft No. 11, near Croton Falls, Putnam Co., N. Y., titanite is not only common but occurs in fine crystals of a chocolate-brown color, in gneiss. Sometimes the gneiss is so thickly peppered with titanite that it becomes a titanite gneiss. As the rock from the shaft is fresh, titanite can often be found in very attractive specimens.

Club and Society Notes

New Haven Mineral Club

The sixth field trip of the year will be held on Sunday, September 15th, at the famous iron mine at Tilly Foster, N. Y. This old mine, abandoned for many years, yields bronzite, clinochlore, chondrodite, magnetite, pyrrhotite, serpentine and a large number of other minerals. It would be advisable to consult the following articles before visiting the locality: Some recent finds at Tilly Foster (*Rocks and Minerals,* June, 1938); Tilly Foster up to date (*Rocks and Minerals,* Oct. 1938 and Feb. 1939); and Another year at Tilly Foster (*Rocks and Minerals,* April, 1940).

Contact Mrs. Sadie Crowley, (tele. New Haven, Conn., 6-5900) regarding time and place of departure.

Mineralogical Club of Hartford

The sixth field trip of the year will be held on Sunday, September 15th, to the famous feldspar quarries at Bedford, N. Y. The locality contains the Baylis, Clinchfield, Colgate, Kinkel and other quarries which are noted for beryl, columbite, hyalite, rose quartz, tourmaline, etc.

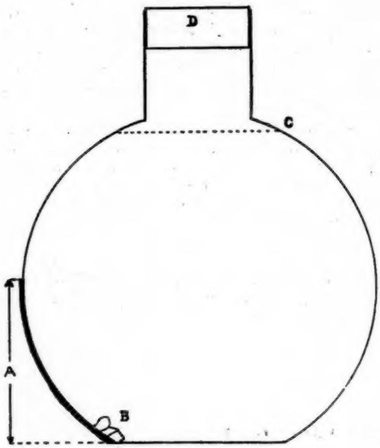
About 200 feet from the quarry property and 100 feet to left of the road is a good spring; the shady area around the spring has been the picnic spot for many collectors visiting the locality—Baylis quarry.

Contact Mrs. R. F. Hills, 35 Manchester St., Hartford, Conn., (tele. Hartford 2-1728) regarding time and place of departure. Bring lunch.

COLLECTOR'S KINKS

Collectors are cordially invited to submit notes from their experiences and so make this department of interest to all.

An Opal Display Bottle



Opal Display Bottle
A—Black paint on outside of bottle
B—Opals cemented in bottle
C—Top of glycerine
D—Stopper sealed with cellophane

A California collector (member of the Rocks and Minerals Association) on a recent trip East had with him three small opal displays which astonished every one who saw them. These displays consisted of small rounded bottles (50 cc. capacity) filled with glycerine in which tiny fragments of precious opal were cemented at the bottom. The opals were attached to the glass with Carter's rubber cement and in the angle at bottom of bottle as shown in the sketch.

In back of the opals and on the outside of the bottle, black paint had been put on—this paint extended about 2 inches in all directions from the opals but not on the bottom of the glass.

The stopper was sealed with cellophane as glycerine absorbs water.

When held in the light the opals gave forth a most gorgeous opalescence while the glass magnified their size.

MORE ABOUT MINERAL IDENTIFICATION TABS

By A. L. FLAGG,
Phoenix, Ariz.

I was tremendously interested in "Collector's Kinks", p. 242, of the July, 1940, issue of ROCKS AND MINERALS, but stick up for the 'painted spot' method of labeling specimens. I began numbering my specimens prior to 1900—that's a long time ago. A little patch of white paint would be put on each specimen which when dried (we had no fast drying paint in those days) would have a number put on, with black paint, using a fine camel's hair brush. At one time I had to work over a museum collection which had gone through a fire. Specimens had not been heated but were all of the same color from smoke, and horribly messed up from the charcoal that fell on them. It was most gratifying to find that about one-third of them bore painted numbers and when washed could be easily identified in the catalog. I know it takes times to prepare them by this method but it pays in the end. The number on my No. 1 specimen, painted on in 1896, is still clear though the white paint background is a bit yellow. So I am a stickler for the painted spot system.

In my work as geologist I found it difficult to label specimens underground, or on the surface, too, in a manner that could be relied upon. Underground they get wet, sometimes on the surface, too, and in sacks they rub against each other and any kinds of marks are obliterated. Some people use small paper slips for

identification and put specimens in separate paper bags or canvas sacks. The average mining engineer does this. I was completely cured of paper tags in sample sacks in 1907 in Mexico. I took a large number of samples and put the regular paper slip in each bag. My samples went five days on mule-back to town for assay. The paper slips were ground to bits and were quite useless. Now I let my children cut up old cans and stamp numbers on them with steel discs. Two of each number are made, one disc being left in the mine where the sample was taken and the other goes into the sample bag. No more question about what the number is now for tin tags never wear out!

. . Collectors' Tales . .

By PETER ZODAC

Watch Your Step!

In 1920 when I was mining engineer for the Ramapo Ore Co., Sterlington, N. Y., an incident happened one day that I will long remember. I was forever exploring mines, especially those that long since had been abandoned, in search of mineral specimens. I happened to visit one day an old abandoned level of the Lake Mine (magnetite) when without warning my carbide lamp went out leaving me in total darkness. Although it had a self-lighter, in vain did I try to relight it. Neither had I matches to partly light my way out. Added to my predicament of being all alone, no one knew I was even in the mine. It was up to me, therefore, to make my way out in the best way possible.

One of the earliest safety-first rules taught me a few years prior to the above incident, while working in the anthracite mines of Eastern Pennsylvania, was that if I ever found myself underground without a light I was to reach for the nearest rail and follow it—always keeping one foot sliding on the rail. In this way, assuming you knew your sense of direction, you would emerge either on the surface or at a shaft.

Fortunately for me, there was an old track on the abandoned level of the Lake mine and my right foot was soon sliding on it, in the direction of the shaft.

I could not have been walking in this manner longer than five minutes when suddenly the bottom fell from under my left foot and down I pitched when just as suddenly my progress was stopped by a cruel jolt which made my teeth rattle. For in my downward plunge I had unconsciously thrown out my right arm which hooked over the very rail I was sliding on.

There I was in the intense pitch darkness—suspended from a rail—half dead from fright and pain and not knowing whether I was only a few inches or many feet above solid ground!

How long I hung there suspended by one arm or how I managed to crawl up to safetly and reach the shaft is a blank to me.

The next day, armed with matches, flash light and a carbide lamp in good working order, I revisited the abandoned level to examine the spot where I had my fall. It was easily found and the site of it made me feel very weak. For the rail at that spot, and for a number of feet in fact, bridged a gap which must have been at least 50 feet deep, vertically. Only a miracle had saved me from almost sure death. Had I walked the other track (inside rail) everything would have been all right as the ground was solid—but I had to pick the outside rail. (Incidently, I didn't find even one interesting specimen on the old level).

This is an instance of how a mining engineer, familiar with underground conditions, may meet with accidents.

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Part 1—Statistical Review of the Mineral Industry of Ontario for 1938 1-54
List of Mines, Quarries and Works 55-71
Mines of Ontario in 1938 72-239
Mining Accidents in 1938 240-249
Classes for Prospectors, 1938-39 250-251

Part 2—Geology and Ore Deposits of the Atikokan Area, by E. S. Moore 1-34
Iron Deposits of the Steeprock Lake Area, by M. W. Bartley 35-47
Geophysical Work at Steeprock Lake, 1938-39, by A. Brant 48-50
23 illus., 4 sketch maps, 2 colored geological maps (in pocket)

Part 6—Geology of the Keezhik-Miminiska Lakes Area, by V. K. Prest, 21 pp., 8 illus., 1 colored geological map (in pocket)

Part 8—Geology and Gold Deposits of the Uchi-Slate Lakes Area, by J. D. Bateman 1-43
Geology at the J-M Consolidated Mine, by J. D. Bateman 44-52
33 illus., 1 colored geological map (in pocket)

Part 10—Geology of the Ashigami Lake Area, by H. W. Fairbairn 1-15
Notes on Several Properties in the District of Sudbury, by T. C. Phemister 16-28
14 illus., 1 geological map (in pocket)

Preliminary Report on the Mineral Production of Ontario in 1939:
Prepared by Maurice Tremblay, (Bull. 126), 25 pp.

All of the above interesting reports are issued by the Ontario Department of Mines, Toronto, Ont., Canada.

Lower Laflamme River Area—Alitibi District:

1—Western Section, by P. E. Auger 5-17

2—Eastern Section, by W. W. Longley 21-33

This interesting bulletin contains 36 pages, 3 plates, and 2 colored geological maps (in pocket). It is issued by the Bureau of Mines, Quebec, Canada.

Dictionary of Geologcal Terms: By C. M. Rce.

The aim of the writer in the compilation of this dictionary has been to bring together in one convenient volume the definitions of terms in use in the various branches of geology: General Geology, Structural Geology, Economic Geology, Physiography, Glacial Geology, Petrology, Mineralogy, Evolution, Invertebrate and Vertebrate Paleontology, Stratigraphy and Geophysics.

A very commendable book that should be in the library of every one interested in geology and mineralogy. Paper cover, 461 pages $6.00.

Copies obtainable from the author, C. M. Rice, 14 Vandeventer Ave., Princeton, N. J.

STRATEGIC MINERALS

(Continued from page 307)

In selecting deposits for investigation, the Bureau of Mines consults with the Geological Survey, and during the progress of exploratory work the Survey will cooperate with the Bureau of Mines by observing disclosures made on each project and aiding in the interpretation of them.

The Procurement Division of the Treasury Department, Washington, D. C., is the agency authorized to make all purchases of minerals, metals, and other strategic materials required by the Government.